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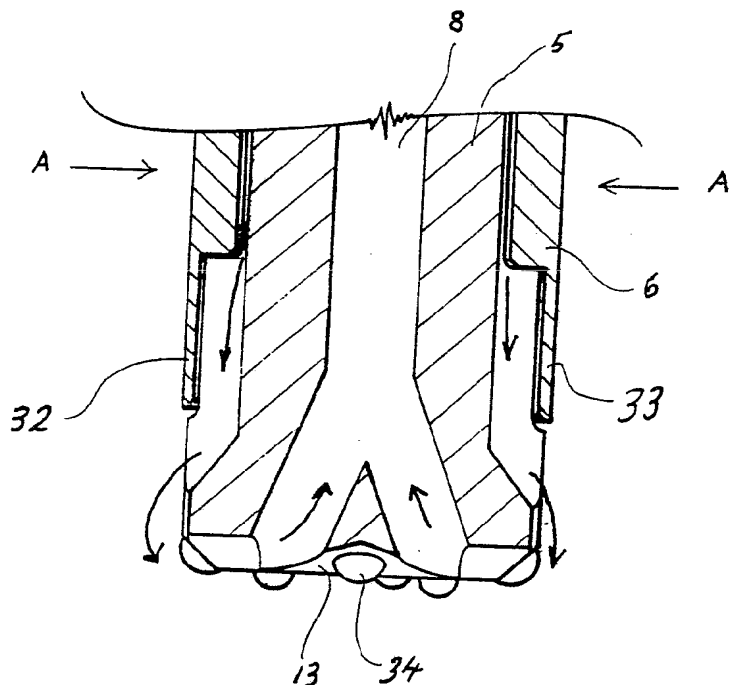
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/AU91/00146 (22) International Filing Date: 19 April 1991 (19.04.91) (30) Priority data: PJ 9682 19 April 1990 (19.04.90) AU (71)(72) Applicant and Inventor: GIEHL, Werner [AU/AU]; 45 Pier Street, Glenelg, S.A. 5045 (AU). (74) Agent: COLLISON & CO.; 117 King William Street, Adelaide, S.A. 5000 (AU). (81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.</p>	<p>Published <i>With international search report.</i></p>	

(54) Title: PERCUSSIVE DRILLING ARRANGEMENT



(57) Abstract

The percussive drilling arrangement (1) uses compressed air to transport chips of material cut by a drill to the surface for collection. The drill head assembly (4) is characterised by a cover means (32, 33) limiting the length of air channels (10, 11) in the drill head assembly (4) exposed to the bore hole before the drill cutting face (13). The air is directed from the channels (10, 11) about the drill bit (5), across the cutting face (13) and into collection ducts (14, 15), picking up the material chips and carrying them to the surface.

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PERCUSSIVE DRILLING ARRANGEMENT

The invention disclosed herein relates to a percussive drilling arrangement for cutting a material. In particular, a typical arrangement uses compressed air to drive a recipricating percussive motor. The motor acts upon a drill head that with rotation of a drill bit effects cutting of material. Air exhausted from the motor is directed to bore hole from the side of the drill head. From there the air flows across the drill cutting face into collection ducts. The air and any picked up chips of cut material are directed through the collection ducts to the surface for collection. The collected chips can then be analysed to determine the nature of the drilled material. A suitable drill bit is described in an earlier Patent Application of mine, namely Australian Patent Application No. 80143/87.

Australian Patent Application No. 80143/87 also describes an arrangement characterised by a drill stem comprising coaxial air ducts. Compressed air flows down one of the ducts to a recipricating valveless motor. The other air duct is connected to the collection ducts. The arrangement allows for collection of material chips from a known drill depth with minimal contamination of other materials from other depths and sources. Such an arrangement has proved to be of significant improvement compared to previous arrangements. But, there has been a problem of significant loss of chips recovered from the cutting head. Experimentation has shown that the air transports only about 70% of the chips the surface.

To discover the cause of loss of chips has required very extensive investigations, trials and discovery. The chips form a very important source of information regarding the cut material. This is particularly the case where substances drilled for are found only in small concentrations.

Accordingly, the problem has been to provide an arrangement by which some greater efficiency of collection of chips can be achieved. An arrangement described hereafter allows significant improvement in efficiency of collection of chips in comparison to prior known arrangements.

The invention may be said to reside in a drill head assembly including a drill bit and cover means, the said head assembly characterised by a cutting face at one end of the said drill bit, the said drill bit including a plurality of open channels extending between air communicating inlets and the said cutting face, at least one collection duct passing substantially axially through the said drill bit and adapted for collection

of air from the said cutting face, and the said cover means covering air inlet proximal portions of the said channels so as to direct air flow to the said cutting face. The drill chuck sub fixes the drill bit to a drill stem.

- 5 In preference, the said cover means are part of a drill chuck sub adapted to affix to a drill stem. Alternatively, the said cover means are fixed about the said drill bit by a drill chuck sub adapted to affix to a drill stem. It will be appreciated that it is a minor matter to design the cover means to be separate but held in place by the drill chuck sub. However, the former is preferred.

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Further, the drill head assembly can be characterised by grooves extending across the said cutting face from the said channels toward the centre of the said cutting face, the said grooves being adapted to direct air from the said channels to the said collection duct or ducts, the said cutting face being concave, the said channels being at least in part of acute profile and adapted to direct air to the proximity of the said cutting face. The grooves enhance the pick up of material chips and dust by the compressed air.

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- Preferably the drill head assembly includes interlocking means adapted to prevent rotation of the cover means relative to the drill bit, the cover means being substantially tubular a maximum diameter of which is substantially the same as the maximum diameter of the said cutting face, a length of the said channels adjacent to the cutting face not covered by the cover means being less than 50% and preferably approximately 30% of the diameter of the said cutting face, and a summation of the widths of the said channel being less than 50% and preferably approximately 30% of the circumference of the said cutting face. It is desirable to reduce air flow up the bore hole. With the maximum diameter of the cover means being slightly smaller than the maximum diameter of the cutting face this can be done.

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- Also, if without undue restriction on the air flow through the channels the length of the uncovered channels is minimised the air flow across the cutting face is maximised. This length has been found to be about 30% of the diameter of the cutting face. It will also be appreciated that too many and too wider channels can weaken the drill bit.

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- Alternatively the invention can be said to reside in a method of drilling with a drill head assembly that includes a drill bit and cover means, the said head assembly characterised by a cutting face at one end of the said drill bit, the said drill bit including a plurality of open channels extending between air communicating inlets

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and the said cutting face, at least one collection duct passing substantially axially through the said drill bit and adapted for collection of air from the said cutting face, the said cover means covering air inlet proximal portions of the said channels so as to direct air flow to the said cutting face, and the method including the step of flowing
5 pressurised air through the said air inlets and channels about the periphery of the said cutting face and into the said collection duct or ducts.

Alternatively the invention can be said to reside in a drill head that includes a plurality of channels each extending from the working face of the drill, the
10 arrangement being characterised in that there is a cowl surrounding the drill head and shaped and adapted with the remainder of the drill head whereby each of the respective channels has it's otherwise open side closed by the cowl to the extent that there is only a relatively short channel part which extends directly from the working face of the drill up the side of the drill head
15 which is not so closed off.

It appears that the channels and the cover means of such an arrangement constrained the air. Further, the air is strongly directed manner about the edge of the cutting face. Then the air flows to the collection ducts. The flow of the air from the
20 channels can be improved by a smooth transition of the channels adjacent the cutting face to the side of the drill head assembly. It was originally believed that the air flow would be directed by the drilled bore from the channels and across the cutting face of the drill bit. Suprisingly, it appears that the where the channels are left open for a significant length the bore hole is insufficient to restrict the air. The result
25 is a significant loss of air and air pressure.

For a better understanding of this invention it will now be described with relation to a preferred embodiment. It is not intended that the invention should necessarily be limited to this specific description.

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To assist in the understanding reference is made to drawings of the preferred embodiment. The drawings are as follows:

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FIGURE 1 is a cross sectional of an assembly including the percussive drive motor and the drill head,

FIGURE 2 is an enlarged view of the drill head with the surrounding shroud,

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FIGURE 3 is a bottom view of the drill cutting face,

FIGURE 4 is a schematic view of the complete assembly of a drilling system,
and

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FIGURE 5 is a sketch of the cross sectional view of the drill head assembly
through line A - A'.

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The drawings illustrate a drilling arrangement for drilling a bore hole in a material.
The surface here is used to denote the distal end of a drilling arrangement often at
ground level where drill stem rotating means and air compressing means are
generally located.

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Referring in detail to the drawings, there is shown a lower portion of a drilling
arrangement 1 including a drilling stem 2, a percussive reciprocating motor 3 and a
percussive drill head assembly 4. The motor 3, under the influence of compressed
air passing therethrough, repetitively strikes the drill head assembly 4. The drill head
4 includes a drill bit 5 and a drill chuck sub 6. The drill chuck sub 6 affixes the drill
stem 2 so that rotation of the drill stem is reflected in rotation of the drill bit 5.

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The drill stem 2 includes coaxially aligned air ducts 7 and 8. Compressed air is
directed down air duct 7 from the surface or borehole beginning. The air flows
through air duct 7 and into the reciprocating motor 3. There the air effects
reciprocating action of the motor 3. Exhaust air from the reciprocating motor 3 flows
into the drill chuck sub 6 through apertures at 9. The air flows through open
channels 10 and 11 to the edge of the drill bit 5 at 12. The air then flows across the
cutting face 13 of the drill bit 5 into air collection ducts 14 and 15 and to the air duct 8.
The flow of air is generally illustrated by arrows 16 to 26.

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At the surface, the air and any chips and dust of material are expelled from the air
duct 8. The chips can be collected for analysis to determine the nature of the
material at certain bore hole depths. When drilling for ores and such occurring in low
concentration the information of depth at which an ore body lies useful.

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Typically a 120 mm. diameter drill bit is used. There are eight identical equally
spaced open channels axially extending from the cutting face 13 as shown at 10 and
11. If desired slightly helical channels can be used. The width of the channels is
constant and approximately 15 mm. wide. Thus the summation of the widths of the

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channels is approximately 30% of the circumference of the maximum diameter of the cutting face 13. More or wider channels or both can be used if desired but this will weaken the drill bit 5. Obviously less or narrower channels or both can be used but this generally reduces the quantity of air that can be flowed about the drilling arrangement.

The drill chuck sub 6 slides over the drill bit 5 to a position limited by the bearing surfaces 27 of the drill chuck sub 6 and 28 of the drill bit 5. Interlocking means are formed between the drill bit 5 and drill chuck sub 6 by splines such as 30 of the drill bit 5 and 31 of the drill chuck sub 6. These splines prevent rotation of the drill bit 5 relative to the drill chuck sub 6. The drill chuck sub 6 includes a covering means, cowl, shroud or skirt as at 32 and 33 to cover the channels as with 10 and 11.

To enhance the air flow from the channels 10, 11 about the edge of the cutting face 13 as shown by arrows 21 and 22 the channels are suitably shaped as at 28 and 29. This takes the form of acute channel profile. Further, the transition from channel covered by the covering means to the edge of the cutting surface being smooth and not abrupt.

The length of the uncovered channels is approximately 60 mm. This length is preferably the minimum possible without undue restriction on the air flow. Substantially larger lengths result in the problem of loss of air pressure, air and material collection that this invention solves. The maximum diameter of the drill chuck sub is approximately the diameter of the bore hole drilled which of course is approximately the maximum diameter of the cutting face.

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- The cutting face 13 of the drill bit 5 is best seen in Figure 3. Across the surface of the cutting face 13 are a plurality of abrasive projections as at 34 and 35. These projections act as cutting teeth to fragment the material. Also crossing the cutting face 13 are a plurality of grooves as at 36 and 37 adapted to assist the flow of the compressed air from the channels 10 and 11 across the cutting face 13 and into the collection ducts 14 and 15. The cutting face 13 is concave that with the other features of the drill bit assists in the pick up of material chips and dust by the air for transportation to the surface.
- 10 As can be seen herein the invention disclosed provides a solution to the problem outlined. It will be apparent to a skilled addressee that there are a number of conceivable embodiments of the invention other than the one disclosed herein. These other embodiments would fall within the spirit of the invention.

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1. A drill head assembly including a drill bit and cover means, the said head assembly characterised by a cutting face at one end of the said drill bit, the said drill bit including a plurality of channels extending between air communicating inlets and the said cutting face, at least one collection duct passing substantially axially through the said drill bit and adapted for collection of air from the said cutting face, and the said cover means covering air inlet proximal portions of the said open channels so as to direct air flow to the said cutting face.
2. A drill head assembly as in claim 1 including the said cover means being part of a drill chuck sub adapted to affix to a drill stem.
3. A drill head assembly as in claim 1 including the said cover means being fixed about the said drill bit by a drill chuck sub adapted to affix to a drill stem.
4. A drill head assembly as in claim 1, 2 or 3 including grooves extending across the said cutting face from the said channels toward the centre of the said cutting face, the said grooves being adapted to direct air from the said channels to the said collection duct or ducts, the said cutting face being concave, the said channels being at least in part of acute profile and adapted to direct air to the proximity of the said cutting face.
5. A drill head assembly as in claim 2, 3 or 4 including interlocking means adapted to prevent rotation of the cover means relative to the drill bit, the cover means being substantially tubular a maximum diameter of which is substantially the same as the maximum diameter of the said cutting face, a length of the said channels adjacent to the cutting face not covered by the cover means being less than 50% and preferably approximately 30% of the diameter of the said cutting face, and a summation of the widths of the said channel being less than 50% and preferably approximately 30% of the circumference of the said cutting face.
6. A method of drilling with a drill head assembly that includes a drill bit and cover means, the said head assembly characterised by a cutting face at one end of the said drill bit, the said drill bit including a plurality of open channels extending between air communicating inlets and the said cutting face, at least one collection duct passing substantially axially through the said drill bit and adapted for collection of air from the said cutting face, the said cover means covering air inlet proximal portions of the said channels so as to direct air flow to the said cutting face, and the method including the step of flowing pressurised air through the said air inlets and

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channels about the periphery of the said cutting face and into the said collection duct or ducts.

5 7. A method of drilling with a drill head assembly as in claim 6 where the said cover means are part of a drill chuck sub adapted to affix to a drill stem.

8. A method of drilling with a drill head assembly as in claim 6 where the said cover means are fixed about the said drill bit by a drill chuck sub adapted to affix to a drill stem.

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9. A method of drilling with a drill head assembly as in claim 6, 7 or 8, the drill head assembly including grooves extending across the said cutting face from the said channels toward the centre of the said cutting face, the said grooves being adapted to direct air from the said channels to the said collection duct or ducts, the said cutting face being concave, the said channels being at least in part of acute profile and adapted to direct air to the proximity of the said cutting face, and the method including the step of directing flowing air to the said collection duct or ducts by way of the said grooves.

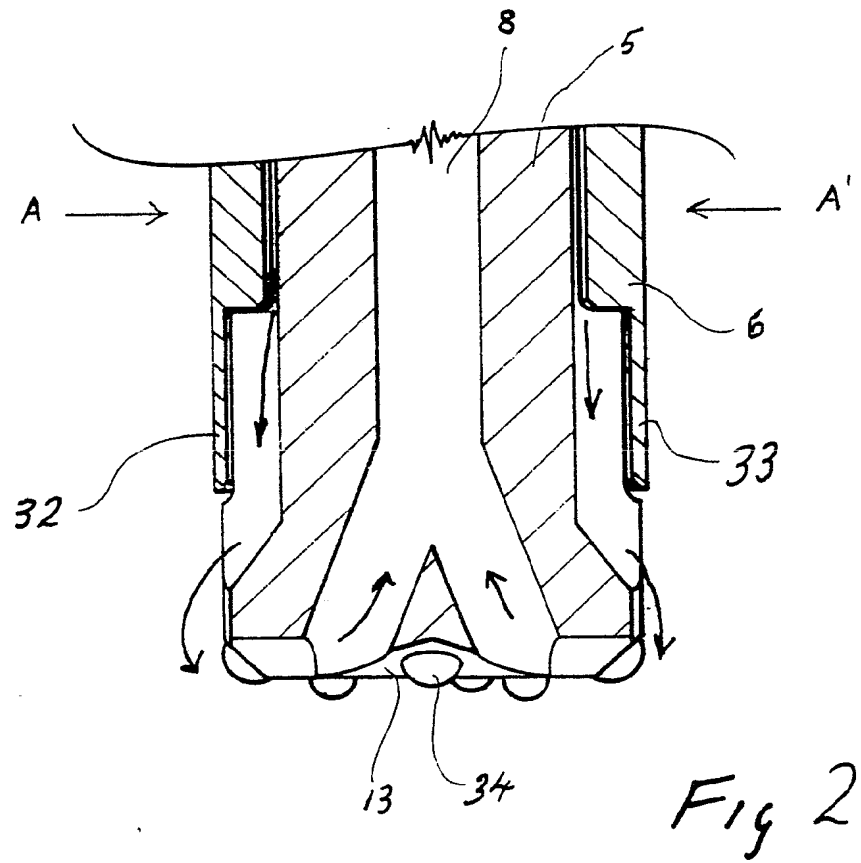
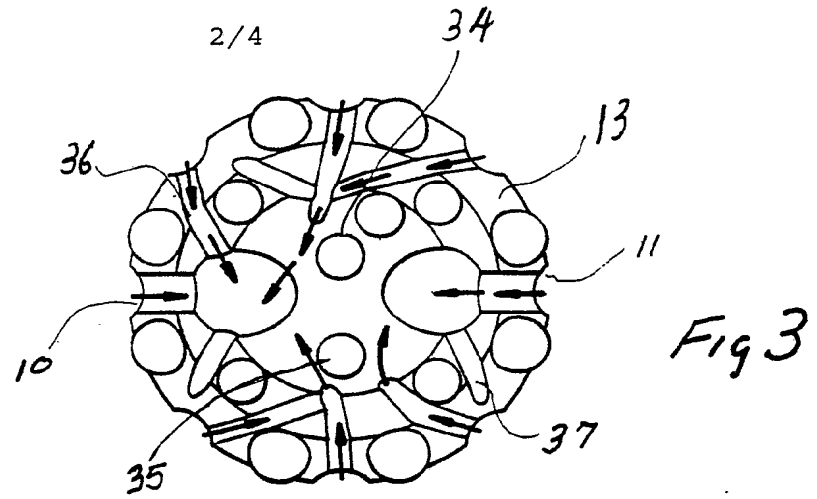
20 10. A drill head assembly substantially as described herein with reference to the accompanying diagrams.

11. A method of drilling with a drill head assembly substantially as described herein with reference to the accompanying diagrams.

Fig 1

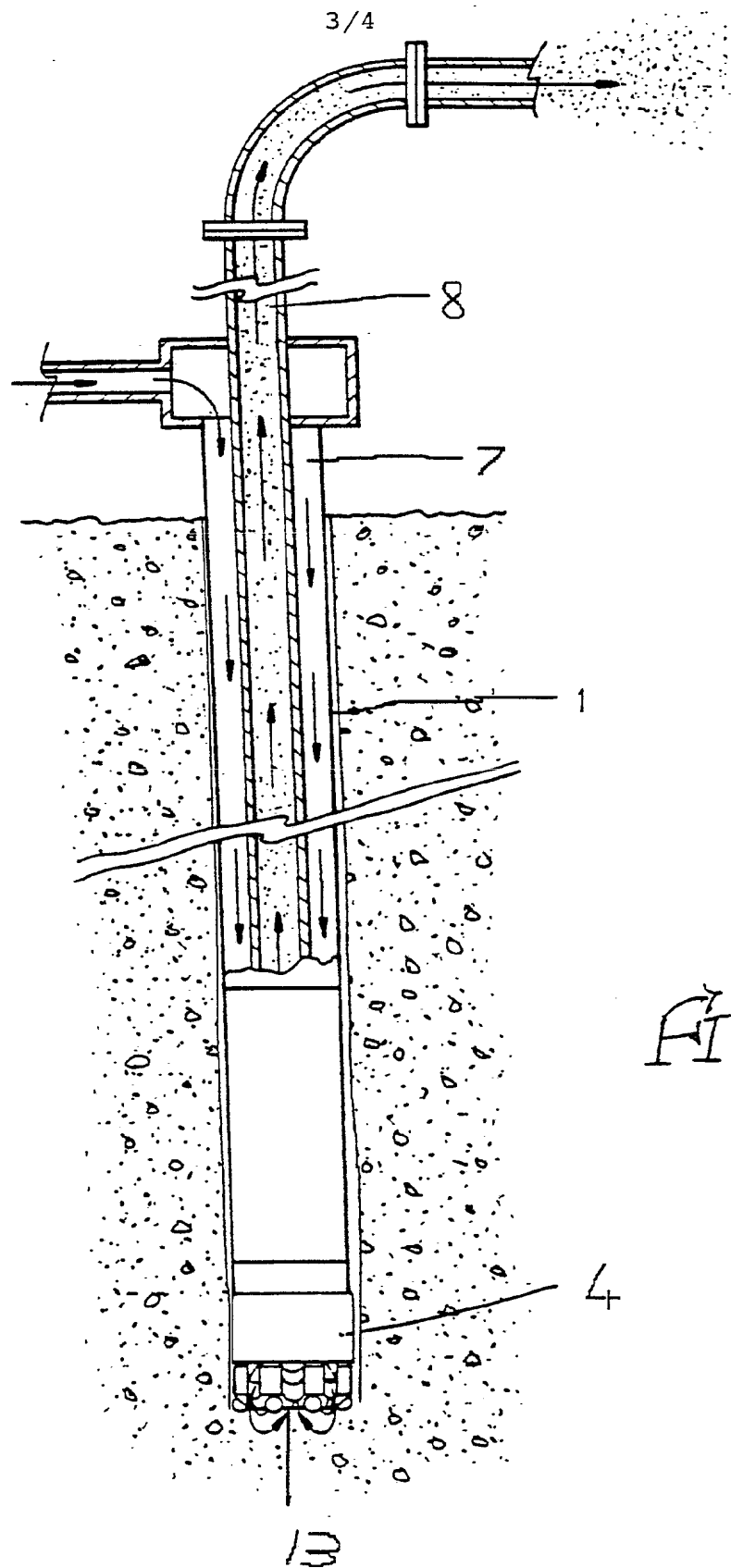
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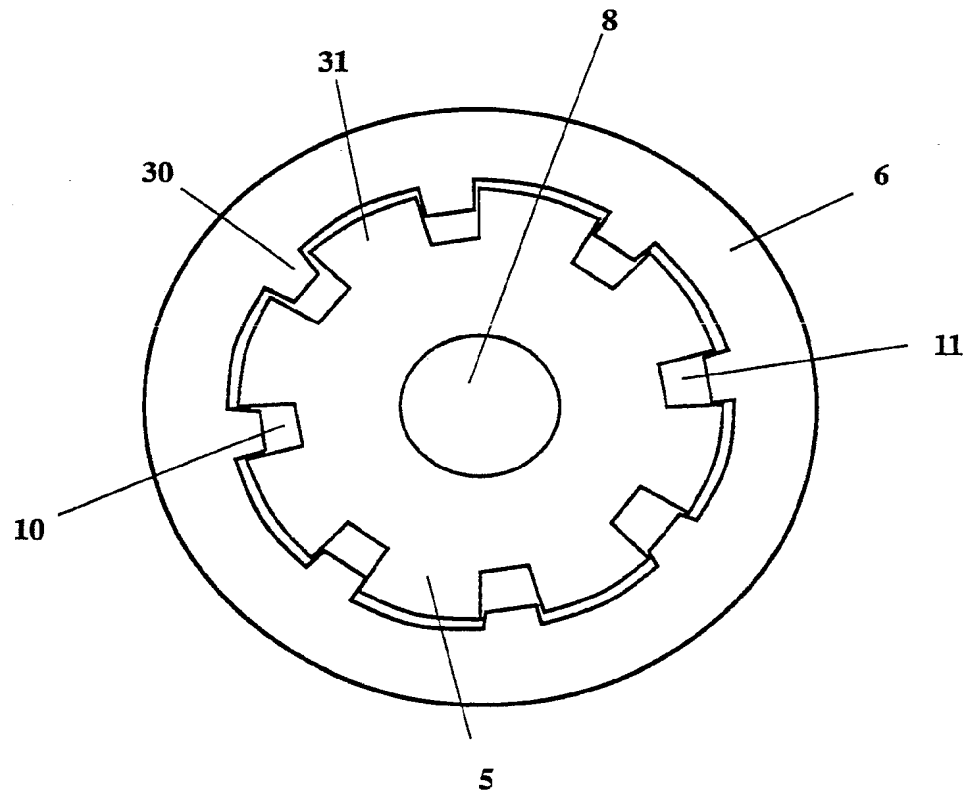
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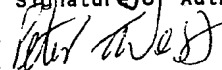
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**Fig 5**

INTERNATIONAL SEARCH REPORT

International Application No. **PCT/AU 91/00146**

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) 6		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int. Cl. ⁵ E21B 10/38, 21/12 // E21B 1/00		
II. FIELDS SEARCHED		
Minimum Documentation Searched 7		
Classification System	Classification Symbols	
IPC ⁵ IPC ²	E21B 10/38, 21/12 E21C 13/08	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched 8		
AU : IPC ⁵ and IPC ² as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT 9		
Category*	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages 12	Relevant to Claim No 13
X	AU,A, 52436/86 (DRESSER AUSTRALIA PTY, LTD) 23 July 1987 (23.07.87) see figures 1-4.	(1-11)
A	AU,A, 58052/86 (WEAVER & HURT, LTD) 11 December 1986 (11.12.86)	
A	AU,A, 80143/87 (GIEHL) 28 April 1988 (28.04.88)	
A	AU,A, 40438/89 (COGEMA) 19 February 1990 (19.02.90)	
A,P	AU,A, 57368/90 (LISTER) 7 January 1991 (07.01.91)	
A	US,A, 3991834 (CURINGTON) 16 November 1976 (16.11.76)	
<p>* Special categories of cited documents: 10</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search 24 June 1991 (24.06.91)	Date of Mailing of this International Search Report 4 July 1991	
International Searching Authority Australian Patent Office	Signature of Authorized Officer  PETER T. WEST	

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE 1

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim numbers ..., because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers , because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers ..., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4 (a):

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING 2

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 91/00146

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Members			
AU 52436/86					
AU 40438/89	BR 8907042 FR 2634818	EP 353168 NO 901368	FI 901485 WO 9001102		
AU 58052/86	EP 204243	GB 2175941			
AU 80143/87					
AU 57368/90	WO 9015220	ZA 9004380			
US 3991834	AU 14114/76 JP 52008903	CA 1037797 SE 7607017	GB 1491393 ZA 7602044		

END OF ANNEX